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ORIGINAL ARTICLE

Prevalence of hypertension and dyslipidemia and their associations with micro- and macrovascular diseases in patients with diabetes in Taiwan: An analysis of nationwide data for 2000–2009

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Background/Purpose: Cardiovascular complication is the leading cause of mortality in patients with diabetes. Dyslipidemia and hypertension are the major risk factors contributing to cardiovascular disease (CVD). This study was carried out to investigate the prevalence of dyslipidemia and hypertension and their associations with microvascular and macrovascular complications in patients with type 2 diabetes in Taiwan.
Methods: Health-care data and diagnostic codes were retrieved from the Taiwan Bureau of National Health Insurance claims files for the years 2000–2009. Based on these data the annual prevalences of dyslipidemia and hypertension were calculated and patients were stratified by age, gender, and diabetic complications.

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Results: In patients with diabetes, the prevalence of dyslipidemia increased with age, with the highest rate recorded in adults (inclusive of both genders) between 40 and 65 years of age (p for trend <0.001). The prevalence of hypertension also increased with age with the highest rate seen in adults (inclusive of both genders) >65 years of age (p for trend <0.001). The prevalence of stroke and CVD decreased gradually (p for trend 0.025 and <0.001, respectively), while the prevalence of peripheral vascular disease (PVD) increased in patients with diabetes during the study period (p for trend <0.001). The prevalence of dyslipidemia increased in diabetic patients with eye diseases and in men with nephropathies, but decreased in women with nephropathies during the study period. In contrast, the prevalence of dyslipidemia decreased in patients with macrovascular complications, including CVD and cerebrovascular disease (cerebrovascular accident), but increased in those patients with PVD (p for all trends <0.05). In diabetic patients with various macrovascular complications, except PVD, there was a decrease in the prevalence of hypertension in the past 10 years. The prevalence of hypertension increased in patients with microvascular complications including retinopathy, patients on dialysis (inclusive of both genders), and in men with nephropathy. The prevalence of hypertension along with dyslipidemia increased in patients with microvascular complications including retinopathy, patients on dialysis (inclusive of both genders), and in men with nephropathy; however, the rate decreased in all macrovascular complications except in PVD.
Conclusion: Although progressively increased prevalence of dyslipidemia and hypertension was observed in patients with diabetes in Taiwan, there was a decrease in the prevalence of stroke and CVD in the past 10 years. Among those with macrovascular diseases, except PVD, there was a trend of decreased prevalence of hypertension and dyslipidemia during the study period. In patients with microvascular diseases, prevalence of hypertension and dyslipidemia in patients with eye diseases increased in the past 10 years. More aggressive management of different risk factors is warranted in diabetic patients with various vascular diseases.

Introduction

The number of people with diabetes mellitus worldwide is soaring with the largest number, an estimated 131.9 million, reported in the Western Pacific region.[1] The number of cases with diabetes in Taiwan is also increasing. According to the claims database of the Taiwan National Health Insurance (NHI) program, the age-standardized prevalence of diabetes in Taiwan increased from 4.7% to 6.5% for men and from 5.3% to 6.6% for women between 1999 and 2004.[2]

Type 2 diabetes is associated with significant morbidity and mortality due to cardiovascular complications.[3] Dyslipidemia, an established risk factor for cardiovascular disease (CVD), affects almost 50% of the patients with type 2 diabetes in the United States.[4] In addition to hyperglycemia and hypertension, dyslipidemia is a modifiable CVD risk factor that remains largely uncontrolled in patients with type 2 diabetes.[5]

Hypertension is another major modifiable risk factor of CVD. In Taiwan, more than 50% of the elderly people are hypertensive.[6] In the United States, approximately 75% of patients with diabetes have concomitant hypertension.[7] There is a significant amount of overlap between the complications of diabetes and hypertension, namely, systemic vascular diseases.

Although advances have been made in the treatment of diabetic complications, cardiovascular complications are still the leading cause of mortality in people with diabetes. Macrovascular complications, including CVD, cerebrovascular disease (cerebrovascular accident or CVA), and peripheral vascular disease (PVD), are the most common causes of mortality in patients with diabetes.[8] Because different methodologies are used to access the complications, there are wide demographic and geographical differences in the prevalence of macrovascular complications among cohorts of patients with diabetes.[8]

To better understand the prevalence of dyslipidemia and hypertension along with macrovascular and microvascular complications in patients with diabetes and their trends in recent years, data from the claims database of the Taiwan NHI program from 2000 to 2009 were retrieved and analyzed.

Methods

Patients and methods

Data source

A universal compulsory NHI program was initiated by the Taiwanese government in March 1995.[9] It provided coverage for 95% of the total population of 22.3 million in Taiwan in 2000, with the coverage increasing to 98% in 2005 and 99.6% in 2009. Large computerized administrative and claims data sets derived from this program have been maintained on an ongoing basis by the Collaboration Center of Health Information Application, the Department of Health (DOH), Executive Yuan, and are made available to investigators for research purposes after personal health information is scrambled. The DOH Mortality Registry also scrambles personal data to link them with the NHI claims

data. In this study, inpatient and outpatient claims data sets from 2000 to 2009 were used. This study was approved by the Institutional Review Board of National Taiwan University Hospital.

Selection of cases

The diagnostic code 250 used for diabetes mellitus was based on the International Classification of Diseases, 9th Revision with Clinical Modification (ICD-9-CM) coding system. Before June 2000, an A code (A181) was used for outpatients only. For privacy reasons, NHRI provided data for only one-third of the randomly sampled patients who were identified as having been hospitalized or having made an ambulatory visit for diabetes (ICD-9-CM code 250 and A code A181) from 2000 to 2009. Patients were classified as having diabetes and included in the analysis if they had at least one admission code of diabetes or three or more outpatient codes of diabetes within 365 calendar days. To avoid the inclusion of misdiagnosed patients, we used the aforementioned selection criteria every year.[10]

The definition of dyslipidemia and hypertension

If the eligible patients with diabetes had also prescribed an Anatomical Therapeutic Chemical code C10 (lipid modifying agents) drug for disease treatment for either outpatient or inpatient care in index year, they were considered to have a diagnosis of dyslipidemia. If the eligible patients with diabetes who also had at least two diagnosis of hypertension (ICD-9-CM: 401—405 and A code A26) for either outpatient or inpatient care within 365 calendar days, then they were considered to have a diagnosis of hypertension.

Demographic characteristics

Demographic information such as patient's age and gender were obtained directly from the Bureau of NHI files. The patient's age was divided into three categories: <40, 40—65, and >65 years. Diabetes-related complications defined using ICD-9, op, or A codes are listed below:

(1) Eye diseases
(1a) All kinds of eye disease: 362.01, 362.02, 362.53, 362.83, 364.42, 379.23, 369.xx, 14.2x-14.5x, 14.7 (A232)
(1b) Blindness and low vision: 369.xx/photocoagulation 14.23, 14.24, 14.25, 14.33, 14.34, 14.35, 14.53, 14.54, 14.55/surgery: 14.21, 14.22, 14.26, 14.27, 14.29, 14.31, 14.32, 14.39, 14.4, 14.51, 14.52, 14.59, 14.7
(2) PVD
(2a) All kinds of PVD: 440.2x, 443.9, 84.1x, 39.25, 39.29, 39.50, 39.59 (A300, A301, A302)
(2b) Amputation of lower limb: 84.1x (nontraumatic, excluding ICD 800-999)/blood vessel bypass surgery: 39.25, 39.29, 39.59/percutaneous transluminal angioplasty (PTA) 39.50
(3) CVD
(3a) All kinds of CVD: 398.91, 402, 404, 410, 411, 412, 413, 414, 428, 36.xx, (A260, A27, A270, A25, A250, A251)
(3b) Myocardial infarction (MI): 410 (acute MI), 412 (old MI)/coronary artery bypass graft (CABG) 36.1x/percutaneous transluminal coronary angioplasty (PTCA) 36.01, 36.02, 36.05, 00.66/stent 36.06, 36.07
(4) Stroke
(4a) All kinds of stroke: 430, 431, 432, 433, 434, 435, 436, 785.9 (A290—A294)
(5) Kidney disease
(5a) All kinds of nephropathy: 250.4, 403, 404, 585, 586, 581.8x, 791.0, 593.9, v42.0, v45.1, v56.0, v56.8, 39.27, 39.42, 39.43, 39.49, 39.50, 39.53, 39.93, 39.94, 39.95 (A350)
(5b) Chronic renal failure: 585/renal transplantation V42.0/dialysis 39.95, v45.1, v56.0, v56.8, [CURE_ITEM_NO1-4]: D8 (hemodialysis), D9 (peritoneal dialysis)
(6) Foot disease
(6a) All kinds of foot infection: foot gangrene 040.0, 440.24, 785.4 with 250.7 or 440.2, 440.21, 440.22, and 440.23/foot osteomyelitis: 730.07, 730.17, 730.27, 730.97, 440.23, 707.14, 707.15, 707.1/cellulitis or abscess of the foot: 680.7, 682.7, 681.1, 681.10
(6b) Foot amputation (ICD-9-CM codes): V49.71—77; V52.1 and (ICD-9 procedure codes): 84.11—17

Statistical analysis

We performed a trend analysis to investigate the trends of prevalence of hypertension and/or dyslipidemia among patients with type 2 diabetes stratified by gender and age from 2000 to 2009. We also used Kendall tau-c coefficient to measure the strength of associations across the years 2000, 2004, and 2008 in diabetic patients with hypertension/dyslipidemia, and those with macrovascular and microvascular complications stratified by gender and age.

Results

Analysis of claims data from the Taiwan NHI database showed that the prevalence of both hypertension and dyslipidemia in patients with type 2 diabetes increased year by year from 2000 to 2008 (p for trend <0.001). The prevalence of diabetes with hypertension plus dyslipidemia increased by more than twofold, from 13.52% to 31.01% in women and from 10.47% to 25.65% in men from 2000 to 2008 (Table 1). In both genders, the peak age for dyslipidemia was 40—65 years, while the peak age for hypertension was >65 years (p for all trends <0.001) (Table 1).

Approximately 10% of the patients with diabetes suffered from CVA between 2000 and 2009 with men having slightly predominant rates (Table 2). The prevalence of stroke showed a steady decrease in both genders in the past 10 years. The prevalence of CVD gradually decreased from 38.14% in 2000 to 33.43% in 2009 (p for trend <0.001), but was higher in diabetic women (34.7%) than in diabetic men (32.2%) (Table 3). The prevalence of PVD increased from 1.87% in 2000 to 2.47% in 2009. There was no gender difference, and PVD was more likely to occur in elderly patients (Table 4).

For patients with diabetes who are diagnosed with several microvascular complications, including eye disease, low vision/blindness, all kinds of nephropathy, chronic renal failure/transplantation/dialysis, and all kinds of dialysis, the prevalence of dyslipidemia was relatively stable during the 2000—2009 study period, except in patients with eye disease and those in both genders who

Table 1 Prevalence of hypertension and dyslipidemia in individuals with diabetes stratified by gender and age in Taiwan, 2000–2009.

Gender	Age	*N* or %	Hypertension				Dyslipidemia				Hypertension + Dyslipidemia			
			2000	2004	2008	*p**	2000	2004	2008	*p**	2000	2004	2008	*p**
F	<40	Number	2847	3465	4872	—	1584	3891	5499	—	609	1368	2106	—
		Prevalence	15.03%	18.76%	22.95%	<0.001	8.36%	21.06%	25.91%	<0.001	3.22%	7.41%	9.92%	<0.001
	40–65	Number	92,310	124,149	160,098	—	36,468	89,253	126,765	—	23,490	55,800	81,300	—
		Prevalence	51.55%	54.95%	58.28%	<0.001	20.37%	39.50%	46.15%	<0.001	13.12%	24.70%	29.60%	<0.001
	>65	Number	118,140	169,116	230,166	—	31,731	82,587	127,146	—	25,020	65,028	101,175	—
		Prevalence	71.41%	74.28%	76.91%	<0.001	19.18%	36.27%	42.49%	<0.001	15.12%	28.56%	33.81%	<0.001
	Total (F)	Number	213,297	296,730	395,136	—	69,783	175,731	259,410	—	49,119	122,196	184,581	—
		Prevalence	58.69%	62.85%	66.39%	<0.001	19.20%	37.22%	43.58%	<0.001	13.52%	25.88%	31.01%	<0.001
M	<40	Number	4419	6627	9897	—	3507	8277	11,937	—	1215	3066	5010	—
		Prevalence	20.02%	24.72%	30.81%	<0.001	15.89%	30.88%	37.16%	<0.001	5.50%	11.44%	15.60%	<0.001
	40–65	Number	80,652	124,929	182,427	—	34,683	92,295	146,253	—	20,139	52,659	88,890	—
		Prevalence	45.11%	48.69%	54.25%	<0.001	19.40%	35.97%	43.49%	<0.001	11.26%	20.52%	26.44%	<0.001
	>65	Number	95,337	130,467	173,787	—	19,248	52,044	82,314	—	14,502	38,946	62,472	—
		Prevalence	67.29%	69.38%	72.03%	<0.001	13.58%	27.68%	34.12%	<0.001	10.24%	20.71%	25.89%	<0.001
	Total (M)	Number	180,408	262,023	366,111	—	57,438	152,616	240,504	—	35,856	94,671	156,372	—
		Prevalence	52.66%	55.58%	60.05%	<0.001	16.77%	32.37%	39.45%	<0.001	10.47%	20.08%	25.65%	<0.001

* *p* for Kendall tau-c coefficient.

underwent dialysis (Table 5). Although the prevalence of diabetes plus dyslipidemia decreased in patients with CVD, including those with MI and CVA, it increased in patients with PVD from 2000 to 2009 (p for all trends <0.001) (Table 6).

The prevalence of hypertension increased in patients with microvascular complications, including all kinds of retinopathy, patients (in both genders) on dialysis, and in men with nephropathy (Table 7), while it decreased in patients with macrovascular complications, except those with PVD in both genders (Table 7). The prevalence of hypertension plus dyslipidemia increased in patients with all kinds of retinopathy, patients on dialysis, and in men with nephropathy. In contrast, the prevalence of hypertension plus dyslipidemia decreased in patients with all macrovascular complications in both genders except in those with PVD (Table 7).

Discussion

Metabolic syndrome is characterized by obesity, glucose intolerance, elevated blood pressure (BP), and dyslipidemia. Each component of metabolic syndrome predisposes people to atherosclerosis, and when clustered together, these components promote atherosclerosis even more prominently. Dai and colleagues studied 1494 healthy Taiwanese patients aged >40 years in 1992–1993 at Taipei City and San-Tze village, and found that the prevalence of each component of metabolic syndrome was as follows: obesity, 29.7%; high triglyceride (TG) levels, 21.7%; low high-density lipoprotein cholesterol (HDL-c) level, 35.9%; high BP, 56.9%; and impaired fasting glucose, 13.1%.[11] Our present study showed that there was an obvious trend of increased prevalence of hypertension, dyslipidemia, and combined hypertension and dyslipidemia in patients with diabetes from 2000 to 2009. Until 2009, 64.47% of patients with diabetes had hypertension, 42.22% of patients with diabetes had dyslipidemia, and 30.09% of them had both (Table 1). In both genders, the peak age for dyslipidemia was 40–65 years, while the peak age for hypertension was >65 years.

Dyslipidemia is a major risk factor for macrovascular complications in patients with type 2 diabetes.[12] Furthermore, type 2 diabetes increases the risk for CVD mortality independent of low-density lipoprotein cholesterol (LDL-c) levels, adding to the greater overall cardiovascular risk in this population.[13] The dyslipidemia associated with insulin resistance is characterized by moderately increased TG levels carried in very-low-density lipoprotein particles, and reduced HDL-c carried in small HDL particles.[5] In patients with type 2 diabetes, LDL particles are small and dense, and carry less cholesterol per particle; therefore, at any given LDL-c concentration, more LDL particles are present in an individual with type 2 diabetes compared with those without the disease.[5]

Data from the United States National Health and Nutritional Examination Survey (NHANES) 1999–2000 showed that <50% of adults having diabetes had total cholesterol (TC) levels <200 mg/dL despite >50% of these patients receiving medication for dyslipidemia.[12] Also, among the patients with type 2 diabetes receiving treatment for

Table 2 Number of cases and prevalence of stroke in individuals with diabetes by gender and age in Taiwan, 2000–2009.

				Year										*P* for trend
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
F	Age group	<40	Number	168	171	186	273	210	225	237	273	222	255	
			Prevalence	0.89%	1.12%	1.10%	1.60%	1.14%	1.21%	1.22%	1.33%	1.05%	1.25%	0.439
		40–65	Number	11,004	11,160	12,024	13,017	13,191	13,323	13,254	13,935	14,412	14,361	
			Prevalence	6.15%	5.97%	6.02%	6.19%	5.84%	5.66%	5.39%	5.35%	5.25%	5.25%	<0.001
		>65	Number	25,965	27,234	30,594	33,513	35,334	37,611	38,739	41,235	43,104	43,560	
			Prevalence	15.69%	15.25%	15.70%	16.03%	15.52%	15.39%	14.90%	14.78%	14.40%	14.16%	0.002
	Total		Number	37,137	38,565	42,804	46,803	48,735	51,159	52,230	55,443	57,738	58,176	
			Prevalence	10.22%	10.12%	10.40%	10.72%	10.32%	10.26%	9.94%	9.90%	9.70%	9.67%	0.02
M	Age group	<40	Number	309	351	291	456	438	465	402	444	540	483	
			Prevalence	1.40%	1.64%	1.25%	1.86%	1.63%	1.67%	1.38%	1.45%	1.68%	1.56%	0.712
		40–65	Number	12,714	13,398	14,862	16,317	17,466	18,450	19,317	20,577	21,909	22,539	
			Prevalence	7.11%	6.92%	6.95%	7.04%	6.81%	6.76%	6.67%	6.60%	6.52%	6.57%	<0.001
		>65	Number	23,883	25,020	28,179	30,861	32,388	34,746	36,222	38,619	41,121	41,715	
			Prevalence	16.86%	16.58%	17.24%	17.76%	17.22%	17.36%	17.14%	17.09%	17.04%	16.88%	0.883
	Total		Number	36,906	38,769	43,332	47,634	50,292	53,661	55,941	59,640	63,570	64,737	
			Prevalence	10.77%	10.60%	10.81%	11.07%	10.67%	10.71%	10.56%	10.50%	10.43%	10.42%	0.030-
All stroke in DM				74,079	77,394	86,193	94,497	99,135	104,820	108,174	115,083	121,308	122,913	
% stroke in DM				10.48%	10.35%	10.60%	10.88%	10.49%	10.49%	10.25%	10.20%	10.07%	10.05%	0.025

DM = diabetes mellitus.

Table 3 Number of cases and prevalence of cardiovascular disease in individuals with diabetes by gender and age in Taiwan, 2000–2009.

				Year										*P* for trend
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
F	Age group	<40	Number	1,680	1,515	1,521	1,467	1,506	1,509	1,422	1,644	1,539	1,536	
			Prevalence	8.87%	9.91%	9.00%	8.60%	8.15%	8.11%	7.34%	8.01%	7.25%	7.51%	0.001
		40–65	Number	58,212	58,668	60,549	62,709	66,525	67,416	68,535	71,700	73,536	71,922	
			Prevalence	32.51%	31.36%	30.33%	29.80%	29.44%	28.64%	27.87%	27.55%	26.77%	26.27%	<0.001
		>65	Number	85,482	90,249	96,987	101,721	110,274	117,081	121,656	127,974	134,256	135,327	
			Prevalence	51.67%	50.55%	49.76%	48.64%	48.43%	47.90%	46.80%	45.86%	44.86%	44.00%	<0.001
	Total		Number	145,374	150,432	159,057	165,897	178,305	186,006	191,613	201,318	209,331	208,785	
			Prevalence	40.00%	39.49%	38.66%	38.00%	37.77%	37.32%	36.48%	35.96%	35.17%	34.70%	<0.001
M	Age group	<40	Number	2,292	2,262	2,508	2,571	2,853	3,024	3,087	3,243	3,435	3,441	
			Prevalence	10.38%	10.60%	10.76%	10.47%	10.64%	10.83%	10.58%	10.63%	10.69%	11.12%	0.045
		40–65	Number	50,016	52,644	56,826	60,519	68,148	72,132	76,425	81,486	86,724	89,142	
			Prevalence	27.97%	27.21%	26.56%	26.10%	26.56%	26.42%	26.41%	26.14%	25.79%	25.99%	0.003
		>65	Number	71,694	74,187	79,023	82,440	88,251	93,597	96,765	101,985	106,767	107,397	
			Prevalence	50.60%	49.17%	48.33%	47.44%	46.93%	46.76%	45.80%	45.13%	44.25%	43.47%	<0.001
	Total		Number	124,002	129,093	138,357	145,530	159,252	168,753	176,277	186,714	196,926	199,980	
			Prevalence	36.20%	35.30%	34.53%	33.83%	33.78%	33.67%	33.27%	32.86%	32.30%	32.20%	<0.001
All CVD in DM				269,613	279,798	297,750	311,805	337,926	354,765	367,890	388,032	406,257	408,765	
% CVD in DM				38.14%	37.42%	36.60%	35.90%	35.76%	35.49%	34.87%	34.40%	33.72%	33.43%	<0.001

CVD = cardiovascular disease.

Table 4 Number of cases and prevalence of peripheral vascular disease in individuals with diabetes stratified by gender and age in Taiwan, 2000–2009.

				Year									*p* for trend
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
F	Age group	<40	Number	63	99	69	93	120	132	105	126	126	165	—
			Prevalence	0.33%	0.65%	0.41%	0.55%	0.65%	0.71%	0.54%	0.61%	0.59%	0.81%	0.042
		40–65	Number	2,745	2,763	2,811	3,141	3,987	4,185	4,488	4,731	5,250	5,394	—
			Prevalence	1.53%	1.48%	1.41%	1.49%	1.76%	1.78%	1.83%	1.82%	1.91%	1.97%	<0.001
		>65	Number	4,125	4,323	4,746	5,322	6,657	7,350	8,055	8,598	9,471	9,819	—
			Prevalence	2.49%	2.42%	2.43%	2.54%	2.92%	3.01%	3.10%	3.08%	3.16%	3.19%	<0.001
	Total		Number	6,933	7,185	7,626	8,556	10,764	11,667	12,648	13,455	14,847	15,378	—
			Prevalence	1.91%	1.89%	1.85%	1.96%	2.28%	2.34%	2.41%	2.40%	2.49%	2.56%	<0.001
M	Age group	<40	Number	96	81	105	108	165	177	240	237	240	225	—
			Prevalence	0.43%	0.38%	0.45%	0.44%	0.62%	0.63%	0.82%	0.78%	0.75%	0.73%	<0.001
		40–65	Number	2,529	2,658	3,138	3,456	4,101	4,674	5,031	5,250	5,853	6,333	—
			Prevalence	1.41%	1.37%	1.47%	1.49%	1.60%	1.71%	1.74%	1.68%	1.74%	1.85%	<0.001
		>65	Number	3,636	3,795	4,155	4,812	5,640	6,387	7,050	7,605	8,253	8,310	—
			Prevalence	2.57%	2.52%	2.54%	2.77%	3.00%	3.19%	3.34%	3.37%	3.42%	3.36%	<0.001
	Total		Number	6,261	6,534	7,398	8,376	9,906	11,238	12,321	13,092	14,346	14,868	—
			Prevalence	1.83%	1.79%	1.85%	1.95%	2.10%	2.24%	2.33%	2.30%	2.35%	2.39%	<0.001
All PVD in DM				13,197	13,719	15,024	16,944	20,685	22,905	24,969	26,547	29,193	30,246	—
% PVD in DM				1.87%	1.83%	1.85%	1.95%	2.19%	2.29%	2.37%	2.35%	2.42%	2.47%	<0.001

DM = diabetes mellitus; PVD = peripheral vascular disease.

Table 5 Prevalence of microvascular diseases according to dyslipidemia and gender in individuals with diabetes in Taiwan, 2000–2009.

Prevalence		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		*P* for trend	
		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia			
		(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)	(−)
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%		
Retino-pathy	F	8.54%	6.06%	9.66%	6.95%	11.30%	7.48%	11.13%	7.20%	11.56%	7.55%	11.93%	8.06%	11.81%	7.87%	11.27%	7.54%	10.97%	7.66%	11.51%	8.24%	0.038	0.005
	M	6.38%	5.67%	7.12%	6.19%	8.26%	6.74%	8.50%	6.69%	9.16%	6.88%	9.27%	7.22%	9.10%	7.15%	8.92%	6.84%	8.51%	6.87%	8.93%	7.49%	0.016	0.004
Low vision/ blind-ness	F	0.51%	0.41%	0.60%	0.49%	0.76%	0.41%	0.70%	0.39%	0.63%	0.38%	0.59%	0.37%	0.63%	0.39%	0.63%	0.41%	0.63%	0.46%	0.68%	0.49%	0.525	0.592
	M	0.58%	0.57%	0.66%	0.52%	0.64%	0.51%	0.66%	0.52%	0.65%	0.45%	0.61%	0.48%	0.63%	0.50%	0.67%	0.51%	0.68%	0.50%	0.74%	0.62%	0.029	0.764
Nephro-pathy	F	17.64%	12.18%	17.63%	12.53%	17.77%	12.33%	17.38%	11.81%	17.33%	11.97%	17.14%	11.88%	16.73%	11.48%	16.91%	11.90%	16.99%	12.43%	16.75%	12.59%	<0.001	0.973
	M	16.04%	12.92%	16.66%	13.29%	17.14%	13.52%	17.15%	13.14%	17.67%	13.28%	17.64%	13.67%	17.61%	13.54%	17.81%	14.09%	18.15%	14.43%	18.27%	14.89%	<0.001	0.001
CRF/transplant/ dialysis	F	5.47%	3.60%	5.26%	3.62%	5.19%	3.73%	5.01%	3.77%	4.75%	3.83%	4.66%	3.81%	4.74%	3.81%	4.96%	4.08%	5.10%	4.36%	5.35%	4.79%	0.427	0.001
	M	4.93%	4.04%	4.96%	4.11%	4.98%	4.30%	4.96%	4.35%	4.89%	4.46%	4.84%	4.53%	4.88%	4.60%	5.15%	5.17%	5.36%	5.31%	5.79%	5.88%	0.026	<0.001
Dialy-sis	F	1.93%	1.37%	1.99%	1.45%	2.06%	1.55%	2.07%	1.72%	1.98%	1.88%	2.04%	1.85%	2.21%	2.00%	2.24%	2.27%	2.32%	2.37%	2.40%	2.49%	<0.001	<0.001
	M	1.68%	1.51%	1.50%	1.54%	1.63%	1.68%	1.67%	1.81%	1.66%	1.91%	1.69%	2.08%	1.87%	2.24%	1.84%	2.54%	2.03%	2.60%	2.00%	2.79%	0.001	<0.001

(+) = with dyslipidemia; (−) = without dyslipidemia; CRF = chronic renal failure.

dyslipidemia, control of LDL-c was only achieved in 29.7%.[12] Consistent with the data from the NHANES 1999–2000, data from the United Kingdom Prospective Diabetes Study in 3713 patients newly diagnosed with type 2 diabetes showed that HDL-c levels were lower (by 9% in men and 23% in women), while TG levels were 50% higher in patients with type 2 diabetes than in nondiabetic patients. This kind of dyslipidemia pattern was more pronounced in females, so it was suggested to contribute to the greater cardiovascular risk in females compared with males.[3] Lin et al investigated 408 drug-naïve patients with type 2 diabetes in central Taiwan, and found that among diabetic men, the plasma TG level was positively correlated with the waist-to-hip ratio (WHR) and alcohol consumption, whereas HDL-c was negatively correlated with age and body mass index.[14] A nationwide survey to evaluate the status of diabetes control in 7542 patients with diabetes in 114 accredited diabetes health promotion centers in Taiwan revealed that only 30.9% of patients met the goal of both systolic BP (SBP) and diastolic BP (DBP) less than 130/80 mmHg, while 35.3% of patients met the goal of TC less than 160 mg/dL or LDL-c less than 100 mg/dL.[15]

In the Western Pacific region, countries with large populations (China and Indonesia) and countries with a high prevalence of diabetes (10% in Malaysia, Hong Kong, and Singapore) contributed to the growing burden of this disease,[16] but the benefits of lowering lipid levels have not been systematically demonstrated in the Asian population.[17] The Asia Pacific Cohort Studies Collaboration meta-analysis examined lipid associations with coronary heart disease (CHD) and CVD death from 17 Asian cohorts including Taiwan. They found that the associations of TC, TG, and HDL-c with CVD were similar to those seen with CHD, but with a lesser magnitude.[17] Data from the Joint Asia Diabetes Evaluation (JADE) program from eight areas in Asia including Taiwan also showed that dyslipidemia and hypertension affected 76.8% and 84.6% of the patients, respectively.[18] In a study conducted by Xu et al in Beijing, China, the prevalence of lipid disorder was as high as 63.8% in the Chinese population in the Beijing area.[19] From our analysis of nationwide data, the highest prevalence was in females aged 40–65 years (46.15%), but this prevalence was lower than that reported in the JADE program or in the study by Xu and colleagues in China.[18,19]

In our analysis, the prevalence of dyslipidemia in patients with microvascular complications remained stable. In patients with macrovascular complications, including all CVD and CVA, the prevalence of associated dyslipidemia decreased in both genders from 2000 to 2009. These results may be attributable to an improved health-care system and promotion of health education in Taiwan.[20] In support of our findings, a diabetic study using data from the Taiwan NHI database showed that the proportion of statin use among all lipid-lowering drugs increased from 20.8% in 1997 to 69.0% in 2003.[21]

Hypertension is one of the most important risk factors for atherosclerosis-related morbidity and mortality. The prevalence rate of hypertension is also growing worldwide, and the rampant increase in prevalence is most serious in Asia.[22] It is predicted that there will be a 65.4% increase in hypertensive men in Asia by 2025 compared with a 54.4% increase in the rest of the world. It will be even more

Table 6 Prevalence of macrovascular diseases according to dyslipidemia and gender in individuals with diabetes in Taiwan, 2000–2009.

		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		*P* for trend	
		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia		dyslipidemia			
		(+)	(−)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(−)
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%		
PVD	F	2.05%	1.87%	2.14%	1.82%	2.04%	1.79%	2.07%	1.90%	2.40%	2.21%	2.46%	2.27%	2.59%	2.29%	2.52%	2.31%	2.68%	2.35%	2.71%	2.05%	<0.001	0.014
	M	1.63%	1.87%	1.94%	1.75%	2.07%	1.78%	2.08%	1.89%	2.21%	2.05%	2.21%	2.26%	2.39%	2.29%	2.27%	2.33%	2.25%	2.42%	2.33%	1.63%	0.02	0.206
Amputation/ bypass	F	0.46%	0.38%	0.39%	0.39%	0.38%	0.38%	0.36%	0.40%	0.37%	0.42%	0.35%	0.41%	0.33%	0.36%	0.33%	0.36%	0.33%	0.35%	0.37%	0.46%	0.13	0.749
	M	0.45%	0.61%	0.53%	0.54%	0.52%	0.52%	0.43%	0.51%	0.48%	0.53%	0.44%	0.54%	0.45%	0.48%	0.38%	0.52%	0.46%	0.53%	0.42%	0.45%	0.074	0.024
CVD	F	50.08%	37.60%	48.27%	37.26%	46.77%	35.92%	44.38%	34.92%	43.26%	34.51%	42.53%	34.22%	41.53%	33.16%	40.51%	32.61%	39.09%	32.14%	38.04%	50.08%	<0.001	0.613
	M	45.37%	34.35%	44.28%	33.38%	42.65%	32.27%	40.85%	31.09%	40.16%	30.73%	39.50%	30.83%	38.89%	30.21%	38.28%	29.53%	37.54%	28.89%	36.95%	45.37%	<0.001	0.583
MI	F	3.16%	1.49%	3.04%	1.37%	2.93%	1.36%	2.70%	1.29%	2.68%	1.25%	2.64%	1.17%	2.39%	1.13%	2.32%	1.14%	2.32%	1.05%	2.37%	3.16%	<0.001	0.351
	M	5.79%	2.30%	5.83%	2.22%	5.62%	2.00%	4.98%	1.95%	4.90%	1.88%	4.75%	1.88%	4.82%	1.79%	4.65%	1.80%	4.89%	1.73%	4.91%	5.79%	0.004	0.257
CVA	F	12.57%	9.66%	12.17%	9.60%	12.36%	9.74%	12.09%	10.06%	11.29%	9.75%	11.06%	9.79%	10.46%	9.60%	10.29%	9.62%	10.11%	9.38%	9.97%	12.57%	<0.001	0.116
	M	11.96%	10.53%	12.02%	10.30%	12.22%	10.42%	11.99%	10.71%	11.30%	10.37%	10.90%	10.62%	10.89%	10.38%	10.71%	10.37%	10.57%	10.33%	10.58%	11.96%	<0.001	0.195
ICH	F	3.68%	2.66%	3.39%	2.58%	3.44%	2.49%	2.91%	2.41%	2.83%	2.42%	2.68%	2.38%	2.60%	2.32%	2.32%	2.38%	2.35%	2.15%	2.28%	3.68%	<0.001	0.521
	M	3.83%	3.09%	3.74%	3.04%	3.51%	3.00%	3.18%	2.93%	3.15%	2.88%	3.01%	2.98%	3.20%	2.83%	2.77%	2.87%	2.94%	2.86%	2.88%	3.83%	<0.001	0.425
CVA-ischemia	F	8.95%	6.37%	8.62%	6.32%	8.64%	6.25%	8.59%	6.73%	7.68%	6.30%	7.49%	6.37%	7.26%	6.13%	6.98%	6.18%	6.80%	5.99%	6.73%	8.95%	<0.001	0.251
	M	8.95%	7.28%	8.91%	7.04%	8.88%	7.10%	8.82%	7.35%	8.10%	6.93%	7.78%	7.12%	7.90%	6.98%	7.64%	6.93%	7.61%	6.87%	7.59%	8.95%	<0.001	0.257

(+) = with dyslipidemia; (−) = without dyslipidemia; CVA = cerebrovascular accident; CVD = cardiovascular disease; ICH = intracerebral hemorrhage (hemorrhagic stroke); MI = myocardial infarction; PVD = peripheral vascular disease.

Table 7 Prevalence of co-morbidities and complications according to hypertension (T), dyslipidemia (L) and gender in patients with diabetes in Taiwan, 2000–2009.

		2000		2004		2008		*P* for trend		2000		2004		2008		*P* for trend		2000	2004	2008	*P* for trend
		T(+)	T(-)	T(+)	T(-)	T(+)	T(-)	T(+)	T(-)	L(+)	L(-)	L(+)	L(-)	L(+)	L(-)	L(+)	L(-)	T+L	T+L	T+L	T+L
Retinopathy	F	7.44%	5.25%	9.93%	7.54%	9.89%	7.54%	0.002	0.004	8.54%	6.06%	11.56%	7.55%	10.97%	7.66%	0.038	0.005	9.41%	12.32%	11.73%	0.049
	M	7.05%	4.38%	8.96%	5.94%	8.58%	5.93%	0.012	0.001	6.38%	5.67%	9.16%	6.88%	8.51%	6.87%	0.016	0.004	7.50%	10.42%	9.40%	0.021
Low vision/ blindness	F	0.49%	0.34%	0.57%	0.32%	0.61%	0.38%	0.033	0.818	0.51%	0.41%	0.63%	0.38%	0.63%	0.46%	0.525	0.592	0.60%	0.73%	0.70%	0.645
	M	0.73%	0.39%	0.63%	0.38%	0.73%	0.34%	0.294	0.813	0.58%	0.57%	0.65%	0.45%	0.68%	0.50%	0.029	0.764	0.74%	0.79%	0.84%	0.171
Nephropathy	F	16.32%	8.82%	16.67%	9.38%	16.94%	9.44%	0.083	0.513	17.64%	12.18%	17.33%	11.97%	16.99%	12.43%	<0.001	0.973	20.32%	19.67%	19.14%	<0.001
	M	17.65%	8.76%	18.78%	9.59%	19.62%	10.29%	<0.001	0.244	16.04%	12.92%	17.67%	13.28%	18.15%	14.43%	<0.001	<0.001	19.70%	21.38%	21.40%	0.002
CRF/dialysis/ transplant	F	4.95%	2.55%	5.11%	2.60%	5.70%	2.67%	0.002	0.260	5.47%	3.60%	4.75%	3.83%	5.10%	4.36%	0.427	0.001	6.39%	5.59%	6.01%	0.589
	M	5.72%	2.50%	6.23%	2.56%	7.00%	2.82%	<0.001	0.029	4.93%	4.04%	4.89%	4.46%	5.36%	5.31%	0.026	<0.001	6.20%	6.38%	6.86%	0.021
Dialysis	F	1.81%	0.99%	2.25%	1.36%	2.80%	1.45%	<0.001	<0.001	1.93%	1.37%	1.98%	1.88%	2.32%	2.37%	<0.001	<0.001	2.19%	2.21%	2.64%	0.001
	M	2.05%	0.97%	2.40%	1.12%	3.06%	1.35%	<0.001	<0.001	1.68%	1.51%	1.66%	1.91%	2.03%	2.60%	0.001	<0.001	2.05%	2.17%	2.59%	<0.001
PVD	F	2.20%	1.49%	2.67%	1.63%	2.85%	1.79%	<0.001	<0.001	2.05%	1.87%	2.40%	2.21%	2.68%	2.35%	<0.001	0.014	2.32%	2.69%	2.90%	<0.001
	M	2.11%	1.51%	2.57%	1.52%	2.82%	1.66%	<0.001	0.088	1.63%	1.87%	2.21%	2.05%	2.25%	2.42%	0.02	0.206	1.84%	2.61%	2.61%	0.018
CVD	F	58.48%	13.75%	51.93%	13.80%	46.23%	13.32%	<0.001	0.016	50.08%	37.60%	43.26%	34.51%	39.09%	32.14%	<0.001	0.613	63.01%	54.54%	48.20%	<0.001
	M	57.77%	12.20%	50.65%	12.68%	45.10%	13.06%	<0.001	0.001	45.37%	34.35%	40.16%	30.73%	37.54%	28.89%	<0.001	0.583	61.39%	53.53%	47.99%	<0.001
MI	F	2.55%	0.76%	2.36%	0.81%	2.03%	0.76%	<0.001	0.281	3.16%	1.49%	2.68%	1.25%	2.32%	1.05%	<0.001	0.351	3.93%	3.32%	2.79%	<0.001
	M	4.15%	1.48%	3.95%	1.49%	3.83%	1.69%	0.007	0.002	5.79%	2.30%	4.90%	1.88%	4.89%	1.73%	0.004	0.257	7.02%	6.13%	5.81%	<0.001
Stroke	F	14.03%	4.80%	13.51%	4.93%	12.04%	5.08%	<0.001	0.330	12.57%	9.66%	11.29%	9.75%	10.11%	9.38%	<0.001	0.116	15.26%	13.80%	11.95%	<0.001
	M	16.05%	4.91%	15.20%	5.00%	13.76%	5.42%	<0.001	0.154	11.96%	10.53%	11.30%	10.37%	10.57%	10.33%	<0.001	0.195	15.83%	14.99%	13.22%	<0.001
Foot infection	F	1.70%	1.12%	1.46%	0.90%	1.07%	0.59%	<0.001	<0.001	1.36%	1.48%	1.18%	1.29%	0.78%	1.01%	<0.001	0.001	1.57%	1.42%	0.91%	<0.001
	M	2.04%	1.62%	1.81%	1.33%	1.41%	0.84%	<0.001	<0.001	1.31%	1.95%	1.30%	1.74%	0.92%	1.35%	0.001	0.001	1.58%	1.57%	1.15%	0.001
Amputation	F	0.42%	0.27%	0.44%	0.23%	0.35%	0.12%	0.021	<0.001	0.34%	0.36%	0.29%	0.41%	0.24%	0.30%	0.001	0.121	0.38%	0.37%	0.29%	0.004
	M	0.58%	0.51%	0.60%	0.38%	0.50%	0.26%	0.009	0.002	0.31%	0.59%	0.41%	0.54%	0.28%	0.49%	0.165	0.059	0.35%	0.52%	0.38%	0.263

(+) = with dyslipidemia/hypertension; (−) = without dyslipidemia/hypertension; L = dyslipidemia; T = hypertension; T + L = hypertension + dyslipidemia; CRF = chronic renal failure; CVD = cardiovascular disease; MI = myocardial infarction; PVD = peripheral vascular disease.

severe in women, with an 81.6% increase in Asia compared with a 54.4% increase in the rest of the world.[22] In a recent survey in Taiwan, the nationwide prevalence rates of hypertension were 25% in men and 18% in women, and the rate increased to 47% among individuals aged ≥60 years.[23] The community-based data from a 10-year follow-up cohort in Taiwan showed that the incidence rates have increased among individuals with prehypertension, obesity, and metabolic syndrome.[24] In our study, we found that for patients >65 years of age with diabetes, the prevalence of hypertension even reached 76.9% in women, and 72.03% in men. These prevalence rates were similar to those reported by Long and Dagogo-Jack in the United States.[7] According to a nationwide survey conducted by Yu and colleagues (2006) in 7541 patients with diabetes in Taiwan, only 30.9% of patients met the American Diabetes Association goal of BP maintenance (SBP and DBP less than 130/80 mmHg), but the percentage of patients with diabetes who fulfilled the ABC goals was only 4.1%.[15] These data reflect the challenges of treating diabetic patients with hypertension and dyslipidemia.

Our findings showed that prevalence of CVD was more markedly increased in women who are aged 40—65 and >65 years than in men in the same age group. Data from the Strong Heart Study indicated that diabetic women had a higher prevalence of MI and CHD than did diabetic men. The prevalence ratios of MI were 3.8 (1.4—10.1) for diabetic women and 1.9 (1.2—2.9) for diabetic men.[25] The authors of the study further demonstrated that diabetic women have increased WHR and have more adverse lipoprotein change, including greater decreases in HDL-c, apoA1, and LDL-c size, than do diabetic men.[26] Thiazolidinediones, which are agonists of peroxisomal proliferator-activated receptor-γ, were shown to have cardioprotective effects and can modify lipid profile. They were introduced in Taiwan since the early 2000s. Chen and colleagues found that rosiglitazone significantly reduces plasma levels of inflammatory biomarkers and restores global endothelial dysfunction, independently from insulin sensitization in healthy smokers.[27] However, whether the use of glitazones has some contribution to the overall decreased prevalence of CHD in patients with diabetes in the past 10 years needs further large-scale studies.

Mortality from CVA was approximately 2.8-folds higher in men with diabetes compared with men without diabetes.[13] Approximately 80% of strokes result from ischemic cerebral infarction in the nondiabetic population and cerebral hemorrhage occurs in the remaining 20% of cases.[28] Studies in diabetic patients have shown a decreased prevalence of hemorrhagic stroke when compared with nondiabetic patients.[29,30] Our study showed that around 70% of stroke cases were of the ischemic type. In the Framingham study, there was a fourfold to fivefold excess risk of hemorrhagic stroke in patients with diabetes compared with those without diabetes.[31] However, diabetes did not seem to have any effect on hemorrhagic stroke in a cohort of the Honolulu Heart Program.[32] The younger population had different risk factors and etiologies of stroke than the older population. Traditional cardiovascular risk factors, such as dyslipidemia and hypertension, were common in older patients, while the major risk factors in younger patients were congenital or acquired heart disease, or cervical artery dissection.[33] The difference in gender proportion was larger in the young stroke population, predominantly with men, than in the older stroke population.[34] A similar effect was found in our study.

In our study, prevalence of PVD in diabetes increased from 1.87% in 2000 to 2.47% in 2009 with female predominance and a rapid increase with age. The prevalence of PVD was approximately two times as high for patients with diabetes, among whom 10% had lower extremities PVD, compared with nondiabetic patients.[35] The prevalence of PVD in diabetes might be underestimated because many people are asymptomatic.[35] The causes of increased PVD in diabetes might be attributable to aging, increased duration of diabetes, and associated risk factors.[36]

In conclusion, we observed a progressively increasing rate of dyslipidemia, hypertension, and dyslipidemia plus hypertension in patients with diabetes from 2000 to 2009 in Taiwan. However, prevalence of stroke and CVD decreased from 2000 to 2009. Prevalence of diabetic dyslipidemia remained stable in those with microvascular complications and, indeed, it decreased gradually in patients with macrovascular complications except those with PVD. In diabetic patients with various macrovascular complications, the prevalence of hypertension decreased in the 10-year interval except in those with PVD. As a result, prevalence of hypertension plus dyslipidemia slightly decreased in diabetic patients with macrovascular complications except those with PVD. Although these trends may be attributable to Taiwan's recent efforts in advocating practice guidelines for diabetic care, establishing diabetes mellitus care institutions and fostering shared care networks, a certain percentage of patients remain at the suboptimal control. More aggressive management of the comorbidities in patients with diabetes is clearly warranted.

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